



Fermilab

PBAR NOTE #456

The H = 84 Accumulator Cavity System
Phase and Amplitude Restorer

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The design philosophy of this rf system was to utilize low cost unregulated anode and filament supplies for the drive train and final amplifiers. It was planned that feedback would be installed such that the low level signal would be varied to have the cavity gap voltage follow the modulated low level command.

During the initial running period in 1985 the feedback was not operational. Amplitude variations of up to 10% (0 360 Hz) and phase variations of 20 degrees where experienced. Temporarily the amplitude was regulated by feedback to the low level source in AP 10, but our tests showed that this loop's response had to be limited to approximatly 1 Khz to prevent oscillations (attributed to the long feedback path, etc.) With this limited response this feedback system was barely able to compensate for the 360 Hz ripple. The phase variations where lowered by stiffening the bias supply.
(Heavier conductors where used for the bias leads.)

A restoring system has now been installed in AP 50 on ARF1-B. This system senses the modulated rf drive (from AP 10) and through a short (less than 200 ns) feedback path compares the cavity voltage phase and amplitude with that of the drive. The amplitude control element is a Mini Circuits ZAS - 1 electrically variable attenuator. The attenuator is offset to place it in midrange with no error signal. With equal amplitude detected drive and feedback signals, the attenuation is about 10 db. (This means that the drive can rise 10 db to compensate for non linearities in the amplifier chain.)

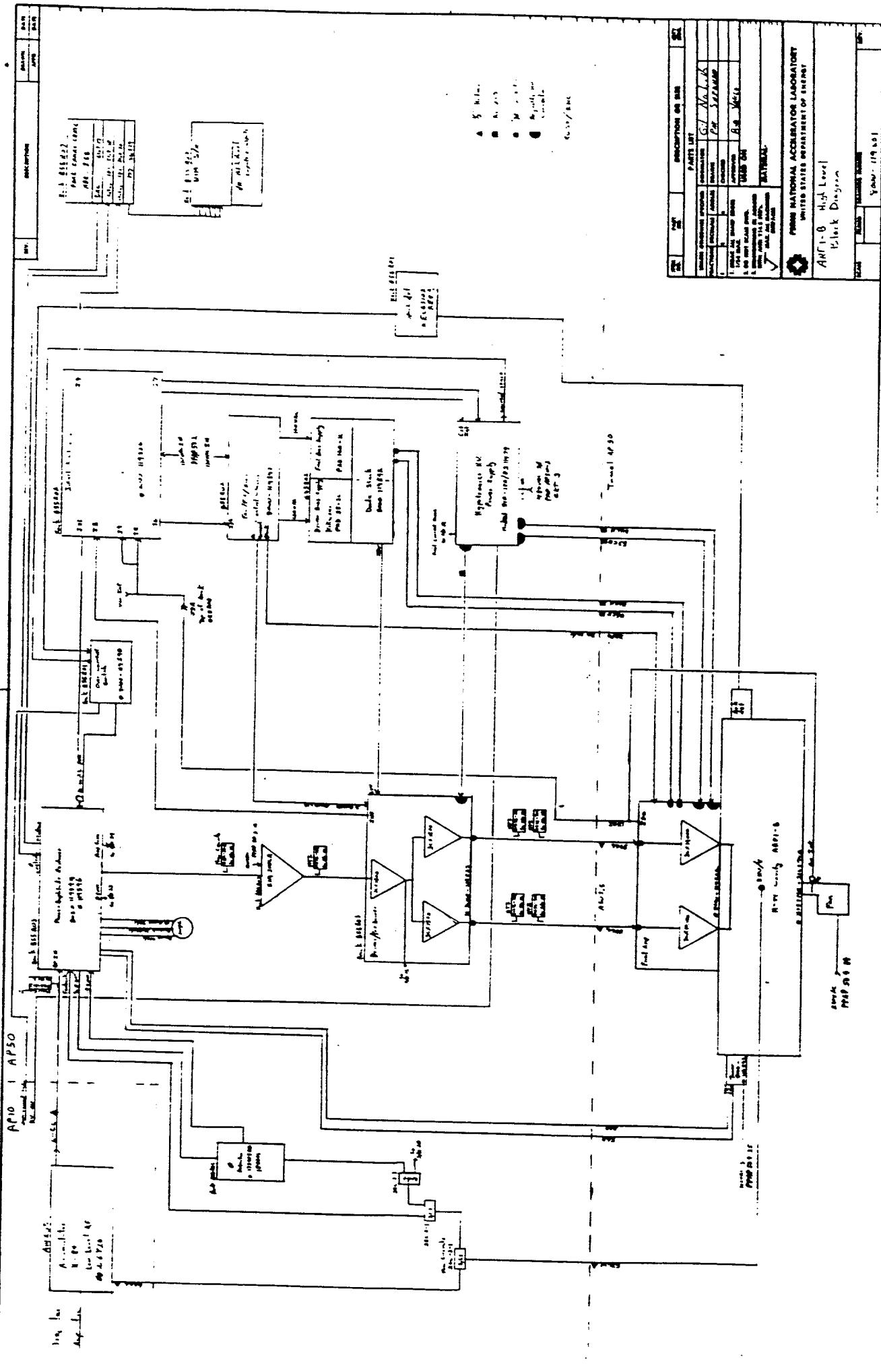
The phase is detected by a Fermilab Overlap phase detector, Dwg. # 1734.05-ED-180201. The phase detector is operated in the 'hold' mode such that the when the drive is removed the last phase error magnitude is retained to the correction element. The reference signal to the phase detector is through a phase shifter which is controlled by a front panel potentiometer. This reference is phase shifted to give a zero phase error at resonance. The error signal is amplified and applied to a fast Merrimac electrical phase shifter PSE 4 - 53 - B. (The PSE 4 -53 - B is offset to put it in Midrange, allowing for detuning to either side of resonance.) Phase errors of 45 degrees are corrected to less than .5 degree.

The error correction signal is amplified and controls two motor operated tuners which have a range of 25 Khz. The tuners compensate for thermal effects and keep the cavity at resonance. Because of the limited tuning range available, the cavity is tuned a little on the high side of resonance (with the tuners out.) so that as the cavity warms up the full tuning range is available to compensate.

The phase error (18 degrees/volt), amplitude regulator 'out of range status', and 'rf ok' status are computer monitored. The amplitude regulator is 'out of range' when the cavity voltage is less than 7 Kv. 'Rf ok' implies that peak overcurrent, spark detector, and the rf interlock chain are satisfied.

The phase and amplitude restorer can be seen at the top middle left of the enclosed ARF1 - B High Level Block Diagram, Dwg. # 8000 - 119601. A block diagram of the system is shown on Dwg. # 8000 - 119594, and the amplifier electronics is shown on Dwg. # 8000 - 119596.

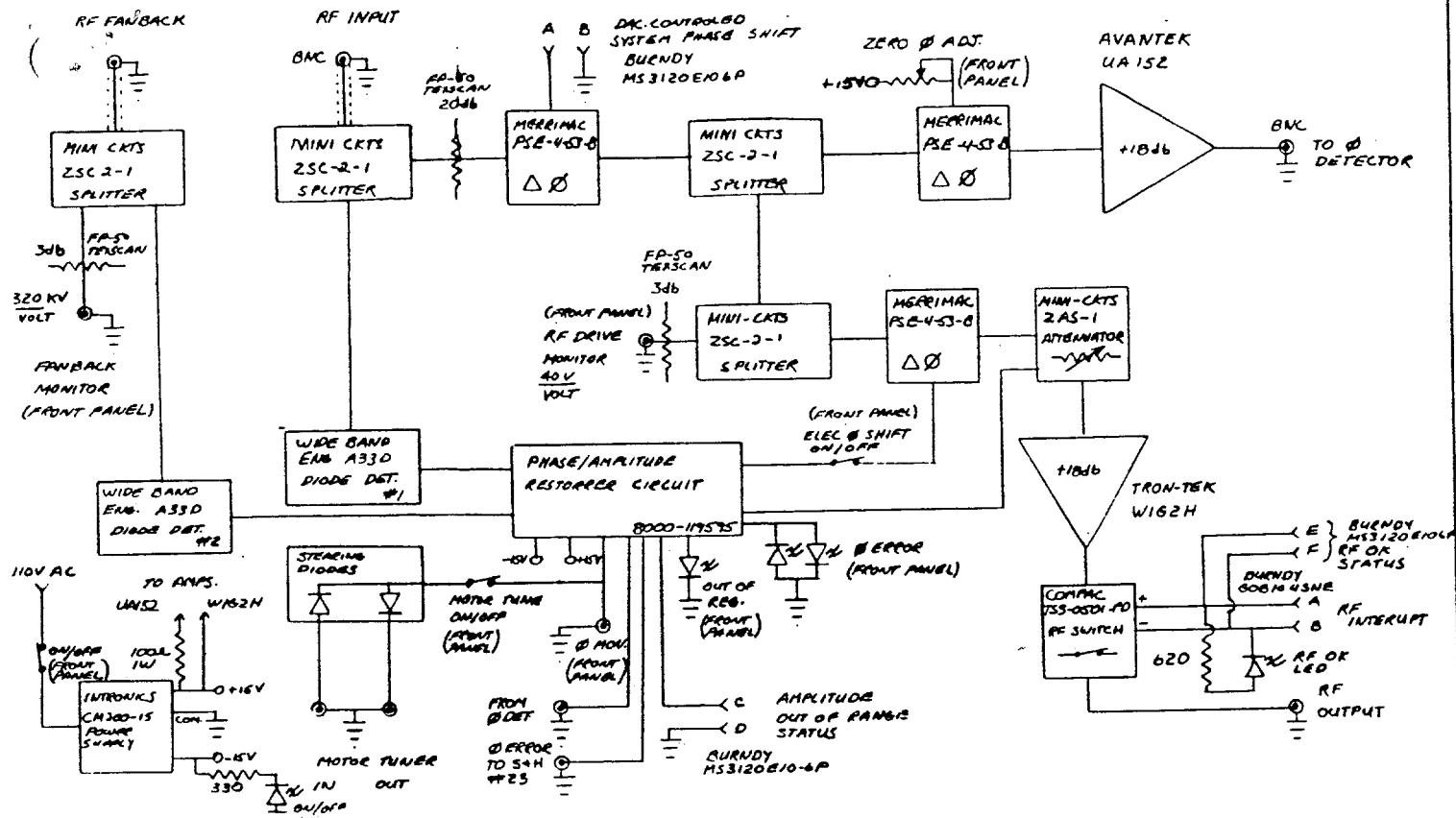
Enclosures: High level diagram, Restorer circuitry, Photographs of tests.



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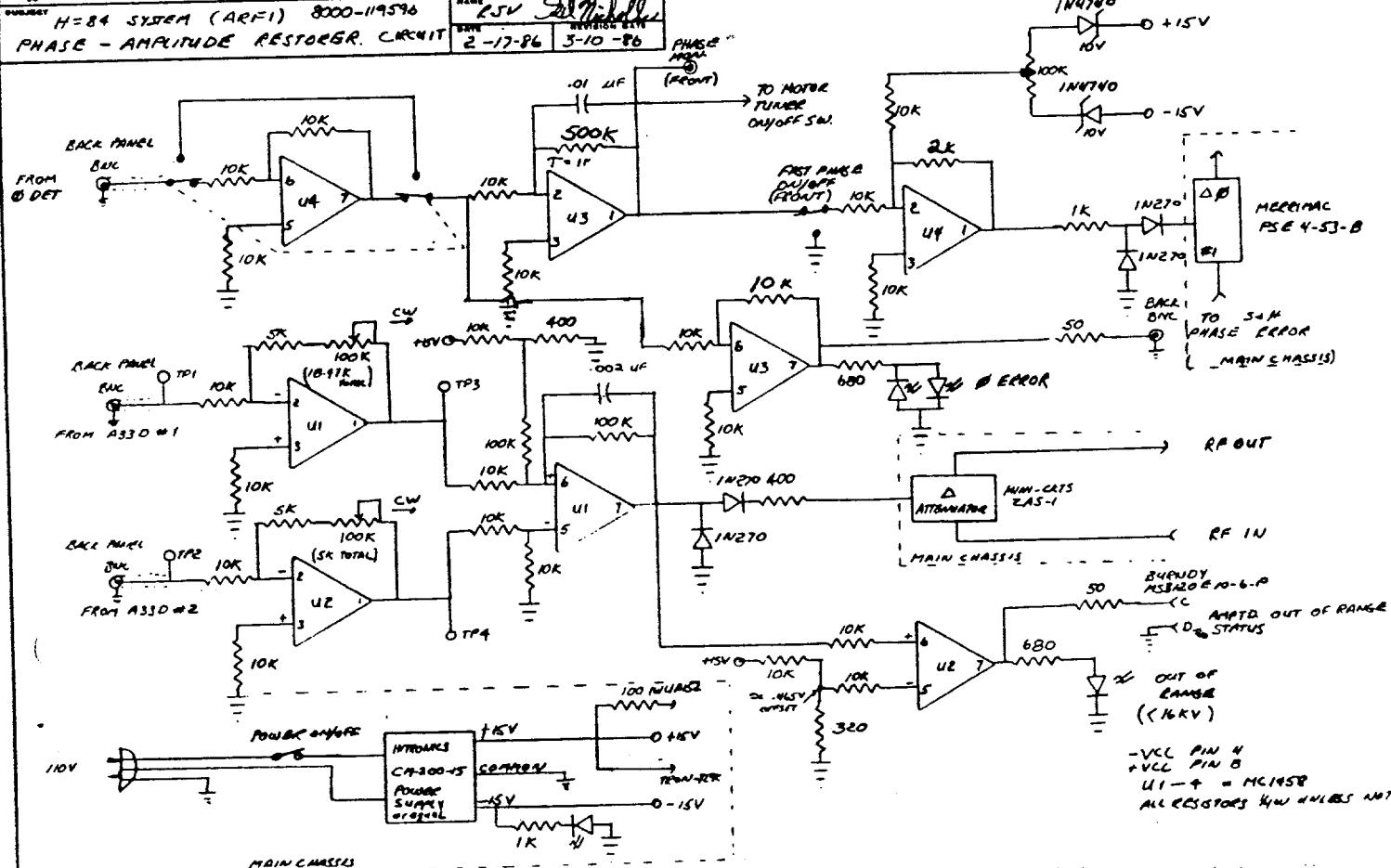
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|---------------------------------|-------------|-----------------|---------|
| SECTION | PROJECT | SERIAL-CATEGORY | PAGE |
| FAST PHASE + AMPLITUDE RESTORER | RJU | 911-1111 | |
| FUNCTIONAL BLOCK DIAGRAM | 8000-119594 | 2-18-86 | 2-17-86 |

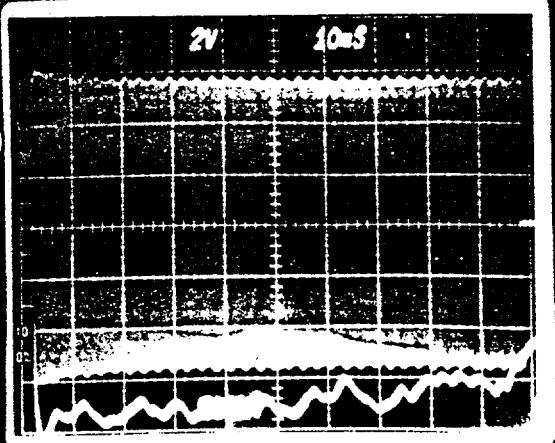
ALL CONNECTORS LOCATED
BACK PANEL UNLESS NOTED



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|------------------------------------|-------------|-----------------|----------|
| SECTION | PROJECT | SERIAL-CATEGORY | PAGE |
| H=84 SYSTEM (ARF1) | 8000-119596 | RJU | 911-1111 |
| PHASE - AMPLITUDE RESTORER CIRCUIT | 2-17-86 | 3-10-86 | |

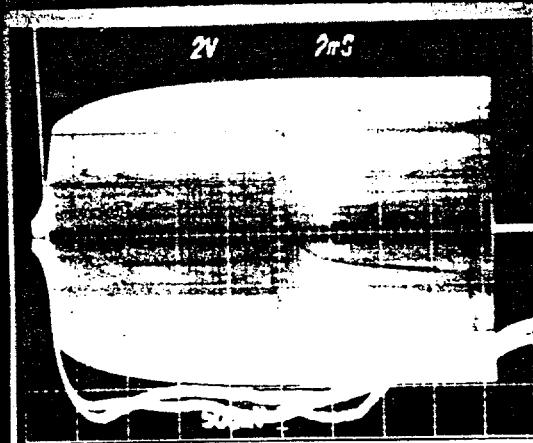




NO LEVELING, NO ϕ CORRECTION

96
KV

2/
18
86



LEVELING ONLY

2/18/86

ARFI-B

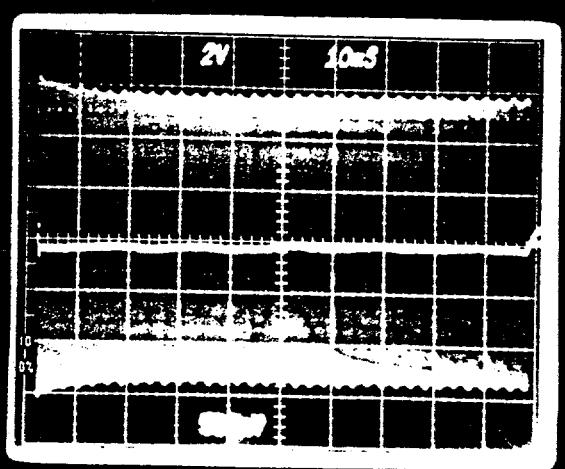
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ARFI-B

200MS

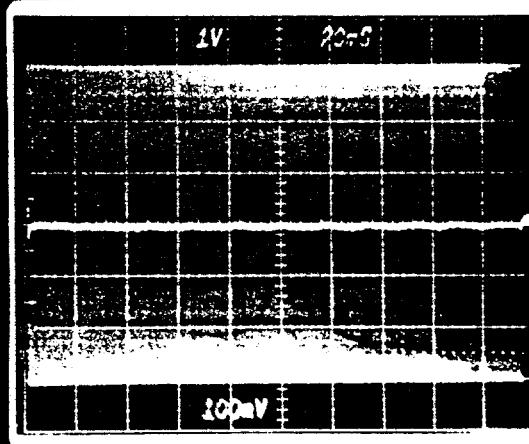
GLN

17



ϕ CORRECTION ONLY

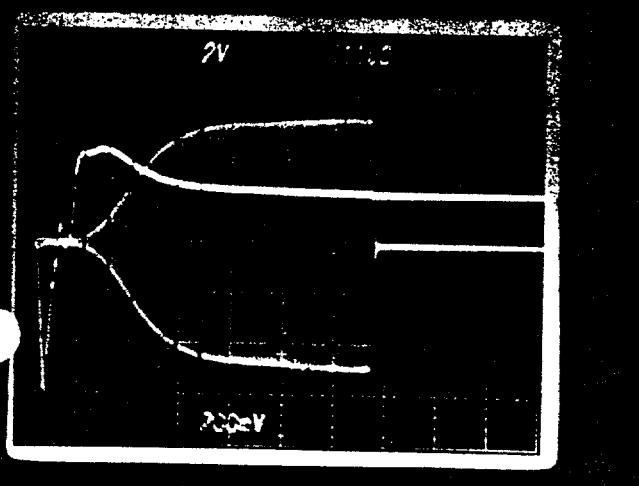
2-18-86



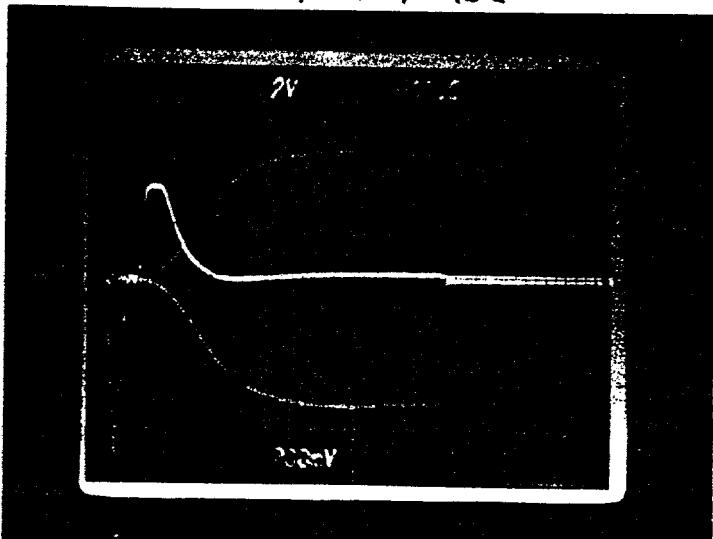
LEVELLED, ϕ CORRECTED

2/18/86

Pulse operation / Open loop Phase Response



Closed Loop Response



↑ CAVITY FILLING PHASE TRANSIENT

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